

ZOOLOGY LIBRARY
10 JUN 1953
As. 6
The Mysore Agricultural Journal

EXD.

(The Organ of the Mysore Agricultural and Experimental Union)

Vol. XXIX]

January—March 1953

[No. 1



IN THIS ISSUE

THE MYSORE AGRICULTURAL AND EXPERIMENTAL UNION

STORY ABOUT LEMONGRASS

A NOTE ON PADDY WORK IN MYSORE

FEATURES OF RICE WORK IN JAPAN AND HOW THEY
DIFFER FROM THOSE IN INDIA

IMPROVED STRAINS OF PADDY IN MYSORE

SUBSIDIARY FOODS

"POCHA'S SEEDS SATISFY"

VEGETABLES
FLOWERS
BULBS PLANTS
IMPLEMENT



ASK FOR
FREE ILLUSTRATED CATALOGUE

Pestonjee P. Pocha & Sons, Ltd.

SEED MERCHANTS

8, Nagpur Road, POONA-1

The Mysore Agricultural Journal

(The Organ of the Mysore Agricultural and Experimental Union)

Vol. XXIX]

January to March 1953

[No. 1

(The responsibility of facts or opinions rests with the several
authors of the articles)

CONTENTS

	PAGE
<i>The Mysore Agricultural and Experimental Union</i>	1
<i>Story about Lemongrass—HANS. E. KARDELL</i>	3
<i>A Note on Paddy Work in Mysore—T. SREENIVASAMURTHY</i> ..	7
<i>Features of Rice Work in Japan and How They Differ From Those in India—K. RAMIAH AND MOTI V. VACHHANI</i> ..	12
<i>Improved Strains of Paddy in Mysore—T. SRINIVASAMURTHY</i> ..	21
<i>Subsidiary Foods—A. K. YEGNA NARAYAN AIYAR</i>	29

THE MYSORE AGRICULTURAL AND EXPERIMENTAL UNION

THIS Association was started so long back as 1918-19. It was the then Director of Agriculture, Dr. Leslie C. Coleman who gave a shape to the thoughts of the founders and started this body. A number of elders helped to work out the objectives of this organisation. Sri. Krishna Iyengar of Ooragahally, Sri. Lakshmanreddi of Sabbanahally, Sri. Srinivasa Rao of Hongenhally, Sri. Venkataswami Gowda of Santehally, and Sri. Bellave Venkatanaranappa, are only a few of the foremost names among the several that fill up pages. It was chiefly the interest taken by those early members to conduct experiments on their holdings and report them that strengthened the foundation of the Union. The yearly programme of the institution consisted in bringing together the reports of these experiments, in arranging for two- or three-day Conference of the members in which several topics relating to agriculture were discussed, and in chalking out a field-day in connection with the Conference at one of the Government Experimental Farms.

An English Journal was started within a year or two of the establishment of the Union. The Journal has just completed its 28th volume ; and as from the beginning, it is being conducted as a quarterly. Following the English publication, a Kannada Journal was also started a little later. It was a quarterly like the English one at the outset, but after four or five years it was converted into a monthly. The English Journal is serving to give us a contact with foreign institutions, and the Kannada Journal is meeting the requirements of local members. In the first and second five-year periods, the average number of our members was 500 ; it has been 3,000 in the current five years.

For the last few years several of our friends have enrolled as Life Members and their number has reached to nearly 270.

The present constitution and activities of the Union are as follows :—

1. Following the increase in the number of members, formation of District, Taluk and Hobli Committees of the Union have been undertaken. These regional branches are helping to realise the objective of bridging the gulf between the research and the practice of agriculture. And several activities of the Union are carried on through these branches.

2. *Field-Days*.—An attempt was made to hold field-days in the villages in addition to those held on Government Farms on the understanding that this would help discussion of agricultural topics in the proper atmosphere, that mutual contact could be secured among the farmers for their benefit and that observation of improvements made in the village environment would be more appealing to them. In the last two years, in addition to Government Farms, local field-days

have been held on private holdings in Channapatna, Abbur, Balepur, Solur, Magadi, Mayasandra, Lakshmisagar, Nelamangala, Thyamagondlu, Talekere, Devanahally and other places. These field-days have suggested several details in regard to such events being made more attractive and useful.

3. Formation of Student Farmers' Clubs is also a recent activity of the Union. These clubs are programmed on the model of 4-H and Young Farmers' Clubs of other countries. A pamphlet was published by the Union detailing the organisation and working of the clubs. Clubs have so far been started at Belur, Hassan, Arkalgud, Channarayapatna, Hoskote, Hosnagar, Harnahally, Shimoga, Konandur; Thirthahally, Maleberinur, Maddur, Mandya, Nelamangala, Bellur, Malvalli, Shiralkoppa, Kolar and other places.

The Union issues badges to students who join these clubs. Three grades of badges are given as the students progress in their work. It is also under consideration to give prizes. When on the subject of prizes, the Union owes its gratitude to Sri. K. H. Srinivasan, who has been our Director of Agriculture; the first step in our declaring the Student Farmers' activity started was made possible by a small donation given by him personally; and later he has instituted a prize for the best club in the Hassan District. The progress of the clubs, it can be said, depends on such help to a considerable extent.

4. In addition to these activities taken up recently, there is the publication of the Journals which has been there from the beginning.

On the basis of these present programmes, help received from Government and our members, and suggestions received and discussed, certain items of future work have been contemplated which are as follows :—

1. To chalk out a programme to considerably increase the number of members.

2. To see that Regional Committees function as study groups.

3. To procure funds and put up a building for the Union at its Headquarters.

4. To review and co-operate with the programmes contemplated by the branches to have buildings at district places.

5. To sponsor Regional Exhibitions of articles produced by members in their places.

6. To organise an Agricultural Museum.

7. To publish small books on different agricultural subjects.

8. To co-operate in schemes of crop competition by way of giving prizes and so on.

9. To arrange for picture shows as pertaining to agriculture.

10. To widen the activity of field-days and Student Farmers' Clubs with a view to variety and utility.

STORY ABOUT LEMONGRASS

BY HANS. E. KARDELL

Extension Specialist (Mysore), T.C.A.

THIS is a story about grass, but not the customary varieties. Neither is it grown for producing milk, but for extracting valuable oil which is used in making sweet-smelling soap, vitamin "A" pills or fragrant perfumes of the best French selections.

My first introduction to Lemongrass took place when Mr. G. N. M. Pillay, Manager of the "Kelly Plantations", Malabar, Madras State, brought a basketful to our office in the Department of Agriculture, Bangalore. He also brought 24 samples of soil from the 1,000 acres area now being developed for Lemongrass production to find out about fertilizer requirements and improved cultural practices. The Spurway Soil Testing Equipment brought along to India from Michigan State College was found very useful in this regard.

At a dinner engagement with Mr. John Willing, Executive Director of the Wynaad Essential Oils (India) Ltd., which also operates the "Kelly Plantation", we were requested to visit the farm. "We" means, Dick Fagan, my partner here, a former Montana agricultural teacher and myself. A few weeks later following an afternoon tea at the Willing Residence, we left by auto with a chauffeur and 2 servants, bed rolls, food, water, etc., for the Wynaad District.

Travelling south-west, a beautiful June day over winding black-topped roads, our first stop was at Mysore City, about 80 miles from Bangalore. The road between Bangalore and Mysore City is lined with stately banyan trees. Many of the branches grow long roots reaching towards the ground and often forming a new tree when ground contact is established. Driving on this road at night reminded me of scenes from the movie "Snow White and the 7 Dwarves". The fields include gently rolling to steep badly eroded slopes. Farmers were out ploughing with their bullocks and ancient wooden ploughs. Rain is badly needed in order to start planting the very important Ragi crop. Ragi is a food millet which together with rice form the main diet of the village folks. We also passed some irrigated areas with promising rice fields and towards Mysore fertile river valleys are decked with majestic cocoanut palms.

About 59 miles from Mysore we stopped at the Madras State border in a densely wooded area to pay toll. "We ought to see some elephants or tigers to-night" stated Mr. Willing. "Last time we drove through this jungle a huge elephant blocked the road. We stopped, turned off the motor and sat there scared stiff hoping he would not

tip our car over." However, we were disappointed not to see any big game that evening.

After driving about 30 miles through jungle we passed by large coffee and tea plantations. The road was rough, narrow and winding up and down the high plateau with peaks up to 5,000'. We reached the Spartan House at the Kelly Plantation at 1 a.m. and after a big midnight lunch we crawled into our bunks sleeping soundly under the mosquito netting until awakened at 7 a.m. by the "bearer" who announced, "Your bath is ready, Sir." No, there was no bathtub or shower in this bath-room, but typical Indian style ; you step into a 3-4" deep concrete square and pour nice hot water over your body using a small brass crock and getting your water-supply from a large earthen vessel.

Looking out of the window we agreed that this is the most beautiful spot we have seen in India. This was also our first sight of lemongrass fields ; that morning we walked 6 miles up and down the slopes observing the growth of the grass, securing more information and being convinced that no tractor is made to-day which is able to navigate on this type of terrain.

About 600 acres are in lemongrass. It is hard to comprehend that all of this land except 4-5 acres was hand-worked in order to bring it under cultivation. Most of the grass was seeded by hand and the seed covered by children literally raking the soil with their fingers. In other parts, the grass was transplanted on the steep slopes to cut down serious erosion. About 170 workers, mostly women and children, are continuously engaged in weeding. A large fern and elephant grass are the most troublesome weeds. We observed about 50 women who were just starting the harvesting operations. They worked in a group cutting the grass by hand with a sickle (*arruval*). They are paid by the "pidi". A "pidi" is a handful of grass tied together with a spear of grass. These small bundles are placed in rows for easier pick-up. About 800 "pidis" form a day's work. The wages are about one rupee per day. 5-6 crops are harvested each year. The average annual rainfall is 140". Heavy rainfall accompanied by strong winds are common during July. Last year 13.8" were recorded on July 23rd and 13.4" on July 24th. As a soil conserver on these long slopes, lemongrass is natural.

A narrow winding road has been built around the slopes. A tractor and two trailers are used for hauling the green grass, to the processing plant. The whole area was at one time a coffee plantation. A few coffee bushes are left in places. Boulders, scattered teak, rosewood and Indian gooseberry trees also adorn the landscape and add to the problem of farm mechanization. The Indian gooseberry is not to be confused with the Michigan variety. Its trunk reaches a diameter of 18" and a



A group of Lemongrass
workers waiting for their
weekly pay.



Two young Lemongrass
cutters. Mr. Willing taking
it easy sitting down by tree.

*Kelly Estate, Wynaad.
Madras State, June, 1952.*



Lemongrass Harvest.

height of 30'. The berries are used for medicinal purposes, pickles and curry.

The processing plant consists of six stills each with a capacity of 700-900 lb. of grass. Wood is now used for fuel, but modern oil burners will soon replace the old wood burners. The grass is kept in the still for about two hours. The oil is directed to a water-cooled aluminium condenser with coils about 25' long. A spring located about 85' from the plant provides water for the operation. The "spent grass" is returned to the soil as a source of organic matter. The whole process reminded me of the Mint processing in Eaton Co.

As high as 1,000 men and women are employed at the peak of the harvesting season. A new one-storey brick building 28' x 81' with tiled roof is under construction to house six families of the regular fieldwork crew. This will be a big improvement over present housing which mostly consists of one room mud huts with cocoanut palm leaves as roofing. It was pay day on the Kelly Plantation when we were there. It started at 1 p.m. on a Saturday and lasted for several hours. The different foremen called the names of their workers and Mr. Pillay, the Manager, paid them off in cash. There were Hindus, Moslems and Christians, but all get along well together, stated Mr. Pillay. Most of them stretched out both hands for their weekly wages. They were all friendly but their features showed a life of toil. The Wynaad Company provides a doctor who lives on the plantation and free medicine and housing. The workers are allowed 14 days' sick leave annually. Each worker is also provided with a blanket each year. The women average Re. 1 per day and the men Re. 1-8-0 (1 rupee equals 16 annas and about 23 cents in American money). The men work mostly in the processing plant, at road building and land clearing.

The extracted oil from each field is tested in a modern laboratory and detailed records show date of cutting, tonnage, weather conditions, time between cutting the grass and processing and perhaps most important, the citral content of the oil and yield per acre.

The *Cymbopogon flexuosus* variety of lemongrass is grown exclusively and the extreme care in hand-weeding and cutting ensures a high quality product.

A big task has been accomplished since Mr. Willing and Mr. Pillay (old army friends) began clearing the mountain side and planting lemongrass in February and May 1951 respectively.

About 6 p.m. we were near a dense jungle and we suggested it would be interesting to cross this jungle to reach the next field. "Let's turn around," advised Mr. Pillay, "we are not armed and in that strip of jungle we might face unfriendly tigers, panthers or elephants, not to mention poisonous snakes". Needless to say we followed his

advice. "Did you ever consider using sheep as weeders," I enquired while strolling homeward on the narrow path. "Back in Michigan commercial strawberry growers use geese as weeders and find it very practical. That lemongrass tastes pretty strong and I doubt if sheep would eat it." "That's worth looking into," replied Mr. Willing, "it might save us a lot of money for weeding". "Yes, and furnish manure for more organic matter and income from mutton," I added.

Mr. Willing was born in England and got his college education in Holland. There he met a young lady who later became his wife and whom he affectionately calls "Kelly".

Lemongrass grows wild in many tropical areas. Distillation of the grass was recorded in the Philippine Islands in the 17th century.

In 1951, U.S.A. imported 900,130 lb. of lemongrass oil at a cost of \$ 2,810,428. India was the main exporter with 476,654 lb., Guatamala second with 252,109 lb. Other countries contributing include Haiti, Salvador, Mexico, Belgium Congo, Switzerland and Brazil,

A NOTE ON PADDY WORK IN MYSORE

BY T. SREENIVASAMURTHY, M.Sc.

Senior Asst. Botanist, Paddy Section

PADDY is one of the most important crops in the State and occupies about 7½ lacs acres. It is one of the important staple foods of the middle and upper classes of the population. The State is largely dependent on outside supplies and considerable quantities are imported every year.

The Agricultural Department has been engaged in the improvement of paddy crop in the State ever since the inception of the Department and two bulletins dealing with green manures and the results of paddy experiments at Hebbal Farm were published as early as 1912 emphasising the beneficial effects of growing green manure crops and the application of green leaf manure with or without other manures to paddy crops and the importance of salt water selection of seeds, transplanting seedlings in singles as against the established practice of transplanting seedlings in bunches as also the use of fertilizers for enhancing the yield of paddy. However, systematic work was only taken up from 1928-29 when a regular survey of local varieties, introduction of improved strains from outside and the isolation of high-yielding strains from selection and hybridization were taken up by the Botanical Section, both for maidan and malnad paddies. Among the outstanding results achieved by the Department prior to this period, mention may be made of the introduction of G.E.B. 24 during the late twenties which, on account of its high yield, greater milling outturn and the fineness of the rice, found favour with the cultivators as well as the millers and within a short period extended practically throughout the channel areas and established itself as a dominant commercial variety fetching a high premium over local varieties.

With the appointment of a Paddy Special Officer during 1939 and the organisation of a separate section, special prominence was given to paddy improvement in the State. A scheme for intensive drive to popularise the strains evolved by the Department was sanctioned. One Paddy Inspector for every taluk having an area of 10,000 to 20,000 acres was appointed. Besides the paddy breeding work carried out at Nagenahally, breeding of punaji, summer and malnad varieties were taken up as also investigation on cultural, manurial and other aspects of the crop. A large number of simple field trials were conducted in subvention farms in the raiyats' fields to find out the suitability of various improved strains for the different localities. Several demon-

strations of popular improved strains were conducted in the raiyats' fields and central seed farms and "A" farms were opened for multiplication and supply of pure seeds of improved strains to meet the growing demand.

At present the section is mainly engaged in the breeding, cultural and manurial problems of rice. Several outstanding and popular strains have been released for cultivators from time to time. The following improved strains are already popular and cultivated on an extensive scale in the State, particularly in the channel areas of Mysore, Hassan and Mandya, *viz.*, S. 661, S. 669 and S. 701 among the Coimbatore sanna selections and S. 139 among the kaddi selections. Recently, S. 749 and S. 718 selections from Rathnachoodi have become extensively popular not only in the channel areas in Mysore and Mandya Districts, but in other localities also and are rapidly replacing other varieties and have become dominant in these areas on account of high yield of both grain and straw and comparative tolerance to *Piricularia*.

Among the punaji varieties, H. 320, a late maturing variety, and S. 199 and H. 294 among the medium duration varieties are becoming popular.

Breeding work on summer paddies have been under way since 1940 at the Central Farm, Hebbal, and a few strains released for cultivation are becoming increasingly popular, particularly S. 705, S. 317, H. 55, S. 547 and S. 497.

Though much work has not been done on malnad varieties, a few strains evolved at Marthur and Bikli Farms have established themselves locally, *viz.*, W. 3629, H.O. 529, B. 281, B. 194; B. 16; B. 888; B. 1370 and B. 1399.

Among the dry land paddies it has been found that fairly satisfactory crops can be raised by the cultivation of Anklo 1-6 and punaji I, two strains imported from Baroda which are better than the coarse, awned paddies now under cultivation locally in low-lying dry lands. Modern paddies of the West Coast have been reported to give good crops in the hill slopes in malnads.

There is considerable scope for the double cropping of paddy, particularly under big tanks and in favourable situations under channels. Several early varieties have been released for cultivation towards this end in view and also for cultivation under small tanks when water conditions are uncertain.

A few promising and late maturing, recent hybrid strains all under trial in the districts are being highly appreciated. They are good tillerers, non-lodging, prolific yielders with high milling out-turn.

Green manuring of paddy fields has been found to be one of the cheapest methods of enriching the paddy soils and the Department

has been emphasising the beneficial results of the practice from a very long time. The raising of green manure crops like cowpea, horsegram, addu, hesaru, etc., has become fairly common in the channel areas, and partly under tanks. In Tumkur, Kolar and Chitaldrug, large quantities of honge and sometimes ugani and such other material, carted from long distances, are applied to the fields before puddling. However, the realisation of the importance of green manuring of paddy fields has not yet been adequately understood. Attempts should be made to plant all vacant and kharab lands, bunds, and road margins, channel bunds, watercourses, tank margins, etc., with honge, cassia, gliricidia, sesbania and other leguminous trees and shrubs so that their leaves can be periodically cut and used for manurial purposes. Growing green manure crops in the field with suitable quick-growing leguminous crops yielding good forage should be taken up systematically both in channel areas and under tanks. Among the various green manure crops sunhemp has been found to be very good and yields : 6,000-10,000 lb. of green matter during the course of 3 months have been obtained. But the crop is susceptible to caterpillar, especially if sown out of season. Next to sunhemp, cowpea of the trailing variety has been found to be fairly satisfactory. The other pulses generally do not yield enough green matter. In lands under tank and channels where the soils can retain moisture and only crop of paddy is taken dhaincha, bogamadura, sesbania, tephrosia and crotalaria can be successfully grown, the seeds being sown just before the harvest of paddy. Lantana which is a pernicious weed and is encroaching in cultivated fields has also been found to be fairly satisfactory as a green manure when it is cut and incorporated into the soil there, by not only making profitable use of this weed but controlling it. In the malnad enough attention has not been paid at present to the problem. On account of the forest areas adjoining the field it is possible to obtain large quantities of green leaf to enrich the soil. Besides, leguminous crops can be sown with paddy itself and incorporated in the soil at the time of weeding.

It has been found that apart from the cultivation of improved strains, cultural practices like proper care of nursery, time of planting, selection and preparation of seeds, cultural operations and judicious manuring go a long way in influencing the yield of paddy.

In order to ensure good germination, paddy has to be specially prepared for seed by harvesting good and fully ripened earheads from robust and healthy plants. The seeds should be thoroughly dried and stored in bags or mudas or straw bundles in a dry place. Further at the time of sowing, the seeds are further selected with brine solution (2 seers of common salt in 5 seers of cold water) to eliminate immature healthy grains and washed and dried in the sun. If sprouted seeds are required for sowing, the seeds need not be dried but put

away in water tray. If proper care and selection of seed are practised it will result not only in a substantial reduction of seed-rate but a uniform stand ; and a better crop can be expected and admixture of inferior types and weed seeds are also eliminated.

There is considerable scope for the improvement in the raising of seedlings in the nursery. The seed-bed should have the proper tilth and raised seed beds are preferable. Rab method of raising nursery has been found to be particularly good and enhances the yield. Heavy manuring is necessary to ensure raising vigorous seedlings at the rate of one cartload of compost for one gunta of seed-bed with a top-dressing of ammonium sulphate at the rate of 100-200 lb. per acre after 10-15 days after sowing seeds in the nursery, if necessary. The present practice of sowing in the nursery thickly at the rate of 25 seers per gunta results in poor growth of seedlings which are thin and lanky lacking in vigour which when transplanted do not establish and put forth tillers easily. As a result, large number of seedlings upto 15-20 will be required for transplanting in each hill. If the nursery is sown thin at the rate of $5-6\frac{1}{2}$ seers per gunta, the seedlings will be robust and vigorous and will be ready for transplanting after 20-25 days and requiring only 3 to 4 seedlings per hill. The present seed-rate varies from 30-60 seers per acre under transplanting and 50-80 seers and rarely upto 100 seers for broadcast sowing. By selection of seeds and proper attention bestowed in the preparation of nursery area the seed-rate may be reduced to 15 seers per acre even allowing for losses, damage by birds, rats and other unforeseen causes. Even in malnad and in the punaji area where the seed-rate is very heavy, it can be reduced by half. Thus, by reducing the seed-rate by 20 seers per acre on the average, it is possible to save more than 1,50,000 pallas of paddy every year.

The time of planting is an important consideration. The optimum time of planting is June-July, and seedlings planted after the middle of September give low yield and become subject to diseases and pests.

Paddy responds to clean cultivation. The plots meant for seedlings should be given at least three ploughings before *Halube* is passed to bring the land under proper condition and to control weeds. The plot should be ploughed to a depth of 4" to 6" ; still deeper ploughing may not have any significance. Mouldboard ploughs are more efficient than country ploughs, particularly in burying green manure and weeds in the soil.

Experiments and demonstrations conducted in various places have proved that economic planting in 3's and 4's were in no way inferior to planting in bunches. On the other hand, the growth and tillering of the seedlings have been better.

Drill sowing is preferable to broadcast sowing since intercultivation can be efficiently carried out and loss of seedlings is minimised and results in considerable saving in seed-rate. Further, if the seeds are sown in drills and covered with harrow, seeds get sufficiently lodged in the soil and the damage by birds and rodents are minimised.

Several experiments have been conducted to find out the optimum age of seedlings and spacing in fields. The general indications are that earlier varieties should be transplanted when the seedlings are 25 days-old and that for late varieties, up to 35 days should be allowed and that the former requires closer spacing $6'' \times 6''$ or less while the latter requires a spacing between $6'' \times 6''$ and $9'' \times 9''$. There is definite deterioration in yield if seedlings beyond 45 days-old are transplanted.

Several simple implements have been tried for paddy cultivation. The mouldboard plough, particularly light type like Eureka plough, have come in common use, particularly in the channel areas since they help to bury the green manure crops more efficiently than the country plough. The puddler of the type manufactured by Messrs. P. S. G. Charities consisting of central rotating axis to which 3 rows of iron blades are fixed is fairly simple and light-weighting, about 80 lb., and can be worked by medium bullocks and has been found to be satisfactory for puddling the lands and can cover about one acre per day. Recently, Japanese type of thresher has attracted some attention and considerable interest.

FEATURES OF RICE WORK IN JAPAN AND HOW THEY DIFFER FROM THOSE IN INDIA*

By K. RAMIAH

Director, Central Rice Research Institute, Cuttack

AND

MOTI V. VACHHANI

Agronomist, Central Rice Research Institute, Cuttack

RICE is the most important single crop in Japan, occupying 7·8 million acres which is 53 per cent. of the total annual cultivated area of 15 million acres. The total production of rice is 10·4 million tons giving an average yield of 2,350 lb. (shelled rice) per acre. Due to the importance of rice in national economy, great attention was given to rice improvement by the Government with the result that during the last 60 years, the area under rice had increased by about 25 per cent. while the acre yields during the corresponding period increased by about 70 per cent. Thus the total production increased from 4·9 million tons during 1880 to 10·4 million tons during 1942, *i.e.*, an increase of 113 per cent. It is due to the higher acre yields of rice and other crops that Japan is able to produce about 80 to 85 per cent. of its food requirements for its population of 78 millions from the annual cultivated area of 15 million acres. The cultivated land of Japan consists mostly of coastal plains and narrow river valleys extending up into mountains. The diluvium is usually sandy and sterile, uplands are leached and soils developed on volcanic parent material consisting of acidic lavas and ash are infertile. Thus the soils are generally poor in natural fertility, and soil fertility is apparently thus not a factor for higher acre yields. The high levels of productions have been attained and are maintained mostly by the application of results of research in practical farming.

It may be useful to consider the organization of crop research and extension service, which combined with the disciplined and progressive ideology of the cultivating classes and the high percentage of literacy in the country, are responsible for such phenomenal results.

The whole country is divided into 46 agricultural districts known as prefectures, each of about 500 square miles. There is a central experimental station at each prefecture and there are 250 technicians for each prefecture or roughly one for each village. This works out to a technical man available to advise for every two to three square miles. These technicians who are either agricultural graduates or suffi-

* Reproduced from *Indian Farming*, 11, No. 2, February, 1950.

ciently trained hands, maintain the liaison between the farmers and the experimental stations, passing the results of research to the farmers, and bringing to the notice of the research stations the problems of the farmers for investigation. Besides, the Agricultural Departments of the six Imperial Universities, the Imperial primary, secondary and tertiary branch stations carry out research on specific crops for different ecological regions and pass on the results and the improved varieties to prefectural stations, who after further testing, multiply the seeds or primary seed propagation farms and the co-operative branch stations under the management of the people in the villages. Due to extensive research and extension service organization with a number of small research stations spread all over the country, manned by a large number of technicians, direct contact with the cultivators is possible and the dissemination of results of research to farmers is made easy.

Rice-Growing Conditions in Japan

Despite the recent urbanization and industrialization, Japan is still a nation of farmers with 43 per cent. of households engaged in farming. About 5.4 million farm households are engaged in tilling an area of 15 million acres which works out to about 2.6 acre holding per family. Thus the average holding is very small and the cultivator and his family pay personal attention to cropping, treating it more as a garden than a field. Because of the north latitude, temperature is low, and rice cultivation is confined to the period April to October.

Japan could be divided into four agricultural divisions from the standpoint of rice crop. The extreme south districts take two successive harvests of rice per year. Central Japan can be divided into two regions, the southern region growing one rice and one dry crop and the northern region raising one crop of rice only. The extreme north, due to its low summer temperatures, is not suitable for rice. Sixty per cent. of the rice fields are left fallow during winter. When two successive crops of rice are taken, the farmer uses an early variety for the first crop and a late variety for the second crop. The first crop is sown in nursery bed in late March, transplanted a month later and harvested by early August. The second crop is sown in nursery beds in July and transplanted after the first crop is harvested. The yield of the second crop is about 60 to 70 per cent. of the first crop.

In general the rice varieties grown in Japan belong to the class *O. sativa* forma *japonica* which usually possess short and stiff straw and have short and coarse grain. The rice crop is classified as paddy rice (low land rice) and upland rice. The former occupies about 95 per cent. of the rice area and is transplanted and irrigated, while

the latter is sown broadcast without irrigation. Attempts are being made to see if direct sowing in lines could replace transplanting.

A brief account of the achievements of research in breeding of improved varieties, in cultural practices and in the use of fertilizers are given below.

Breeding of Improved Varieties of Rice

Rice breeding in Japan is carried on according to the traditional methods of selection, introduction and hybridization. The basic sciences, especially genetics, cytology and plant pathology, have played an important role in developing the improved varieties. Of late, much attention is being paid to genetical-ecological approach to plant breeding. By this is meant the determination of the reaction of varieties to specific climatic, edaphic and biotic environmental factors.

Rice breeding work in Japan was started as early as 1893 when the Ministry of Agriculture and Forestry established the Imperial Agricultural Experiment Station in Tokyo and its six branch stations in different districts. They collected 4,000 native rice varieties from all over the country which were carefully examined for various characteristics and yielding capacity. Several superior varieties were thus isolated which became popular and their cultivation extended to wide areas. The pure line selection method was first used in 1910 and because of its simple technique and effective results, the method was adopted on the prefectural and branch stations. This method was very successful and by the year 1922, 490 new strains for various parts of the country were isolated.

Hybridization or cross-breeding for rice improvement was first used in 1904 for combining in a single strain the desirable characters of high yield, disease resistance and cold resistance. Certain varieties which were resistant to the most important rice disease of Japan, caused by *Piricularia oryzae*, were used in the hybridization programme. Up to 1925, 50 new varieties had been developed by this method.

As already mentioned, the hybridization since 1926 has been remodelled and the new method is mostly based on the genetical-ecological conceptions. For this purpose, the whole country has been divided into ten main ecological districts based chiefly on climatic, soil and biotic factors, each having a local rice research station, called a secondary breeding station. Under this scheme, the whole set-up of rice breeding consists of seven primary breeding stations under the control of the Imperial Government, where the programme of breeding, choosing of parents, making the crosses and growing and study of F_1 and F_2 progenies are carried out. The selected F_3 progenies from these stations are distributed to secondary stations, where the behaviour of the F_3 progenies and later generations are studied and the selections made in

accordance with the local requirements. These selections are subjected to preliminary trials for yield and resistance to diseases. When the superiority of these varieties is established, they are sent to prefectural stations for final tests and if the results are confirmed, the variety is given a *Norin* number and is taken to seed farms for multiplication and distribution. By this method 16 new *Norin* varieties have been evolved which are widely cultivated.

The success of the rice breeding programme can be gauged by the fact that 69 per cent. of the area under rice is grown under improved varieties, 46 per cent. under the varieties developed by hybridization and 23 per cent. under the varieties developed by pure line selection. According to the estimates of rice experts, the increase in yield of the line selections based on the average of 261 strains was about 9 per cent., whereas the increase in yield of 20 varieties developed by hybridization was about 16 per cent.

Improved Cultural Practices

Use of Good Disease-free Seeds.—The cultivators are conscious of the advantages of the improved varieties and renew their seeds very frequently and often every year, which is made possible due to the existence of a large number of agricultural co-operatives, one in each village. The cultivator usually gives his own produce to the co-operatives in exchange for the improved seed he gets.

In order to get assured and uniform germination, the seed is sifted through a sieve and then put in salt water solution to float out the light seeds. The seed is treated against fungoid diseases mostly with the mercuric compounds before sowing.

Nursery and Field Practices.—Ninety per cent. of the rice crop is transplanted and great importance is attached to healthy and vigorous seedlings for transplanting. The nursery area is well prepared and laid out in rectangular beds with raised side bunds and having a width of $3\frac{1}{2}'$ to $4'$ and length according to requirements. The seed-beds are invariably manured with organic and inorganic manures before sowing. Mostly sprouted seeds are sown either by hand or by special drilling machine which deposits five seeds in each hole. Frequent weeding is done to keep the seed-beds free of weeds and the spraying of the seed-beds with fungicides and hand-picking of egg masses of insects is a very common practice. In the northern districts where the temperature at planting time is low, hot beds are used to get quicker and satisfactory germination.

The holdings in Japan being small, the land is mostly prepared with hand tools and sometime with implements driven by animal power. The Japanese cultivator is very disciplined and hard-working and promptly carries out the recommendations of the technicians. The

main operations of paddy field consist of dry ploughing and puddling, irrigation, making bunds and levelling. Liberal doses of both organic and inorganic manures are applied at the time of preparation of land and after transplanting, the details of which are given elsewhere. The transplanting is done mostly in June and July at distance of $9'' \times 9''$ with 4-5 seedlings per hole. The crop is usually irrigated and 4-5 weedings are given either with hand or with implements, the latter being possible only in fields where the distance between rows is wider. Weeding is considered a very necessary practice, the first weeding being given a fortnight after transplanting, and subsequent ones at an interval of 10 to 15 days.

Harvesting and Preparation of the Produce.—The rice crop is cut close to the ground with sickle as in India. Threshing is either performed by human labour or motor power. Japan has made much progress in designing small power-operated machines for threshing, winnowing and hulling operations. Power threshers are operated by 3-5 h.p. gasoline engines or by electric motors, all operations being performed at the same time. Motor threshers are community-owned and are commonly used by the farmers in the village community.

Application of Fertilizers

As stated already the soils of Japan are rather low in fertility and can supply only about two-thirds of the important plant food ingredients necessary to produce a good rice crop. Thus various methods are practised, which are standardised as a result of extensive manurial trials conducted in the country.

Manuring of Nursery Beds.—Complete fertilizers are applied to the nursery before sowing and thoroughly mixed with the soil. On an average, about 5 to 6 lb. of N and 3 to 4 lb. of each of P_2O_5 and K_2O are applied to a seed-bed area of $1/25$ th of an acre which is sufficient to transplant about an acre of paddy field. Wood ashes are applied when the seedlings are about 1" in height.

Manuring of Paddy Fields.—From experiments it has been found that application of complete fertilizers gives the best results. Based upon the properties of the soil, the average amount of the main plant food ingredients applied is 80-100 lb. of nitrogen and 70-80 lb. of each of phosphoric acid and potash per acre. They always use the combination of organic and mineral fertilizers.

As regards organic manures there obtains the practice of growing a green manure crop, mainly of soyabean, which is cut and ploughed under about three weeks before transplanting. The amount of green matter thus added varies from three to five tons per acre. The field is then irrigated and often about $1/3$ ton of lime per acre is applied to promote decomposition of the green manure ploughed in. Besides

green manure other organic manures like soyabean cake, night soil and composts made from farm wastes are also extensively used. The organic manures are applied to the land before ploughing.

The most effective method and time of application of concentrated manures have been determined from the standpoint of rice physiology. As a result of these investigations two-thirds of the quantity of the ammonium sulphate and phosphate and potash is applied in the dry condition just before puddling and the remaining one-third is applied in two later applications, one about three to four weeks after transplanting, and the other two to three weeks before ears emerge. This is supposed to prevent ammonia escaping as gas from the soil and improve the effectiveness of nitrogen. Ammonium sulphate is the common nitrogenous manure applied, of which about one million tons were produced in Japan before the war. During the war due to the non-availability of enough quantities of this fertilizer, the yields are said to have come down.

According to the Japanese investigations the use of commercial fertilizers and better varieties are dependent upon each other. That is to say, the improved varieties produced in recent years are better only when heavily fertilized and also improved varieties must be grown if the full benefits of fertilizers are to be expected.

The question of water facilities in Japan as compared to what obtains in India may also be considered. Irrigation facilities in Japan are only afforded to the paddy crop and 90 per cent. of the crop is irrigated. It is stated that at the time of sowing and transplanting there is always plenty of water available. The sowing and transplanting are carried out expeditiously within a short period during which the assured water is available. There may be difficulty of obtaining water in the later period but this is not considered as serious as scarcity in the earlier stages, as it is known that early and timely planting contributes more to satisfactory yields. In India the failure of early monsoon delays the planting and ultimately affects the yield adversely and even in canal-irrigated tracts, there is always insufficiency of water in the beginning to get through the planting expeditiously. In fact the canal supplies as in parts of Orissa become plentiful only when the monsoon has set in strongly and there is not very much need for the canal water at that stage.

Rice being the master crop and the characteristic food of the entire population of Japan, the yields have been raised by skilful cultivation, fertilization and scientific seed development. To sum up the main features responsible for higher acre yields can be said to be :

- (i) use of improved seeds,
- (ii) intensive fertilization,

- (iii) assured supply of irrigation water for the crop,
- (iv) control of diseases,
- (v) the large number of technicians available for giving advice to the farmers,
- (vi) the high percentage of literacy among the people,
- (vii) the large number of agricultural co-operatives, and
- (viii) the personal attention each cultivator pays to rice cultivation, treating it more as a garden than a field crop.

We can now compare the position of India with that of Japan.

Improved Seed

The work of breeding improved varieties is well advanced in India and in several of the Provinces there are improved varieties available suited to the different tracts. The testing of these improved varieties is however not thorough in some of the Provinces. This might have to be undertaken immediately so that the areas suited to the different improved varieties could be delimited before an intensive seed distribution organization could be set up. There is also great scope for intensifying breeding in some areas to obtain varieties not only with higher yields but also with improved auxiliary characters.

The dearth of sufficient technical personnel will however be an obstacle to overcome particularly in Bengal, Bihar and Orissa. We shall also require many more experimental stations than what we have. Though there has been considerable improvement in seed multiplication and distribution organization in recent years, we will still be behind Japan for a long time to come before the ideal condition of each village having a seed area to meet the requirements of the village every year could be reached. It is mainly through the agricultural co-operatives which exist in each village that Japan has reached this ideal condition.

Intensive Manuring

This is a more fruitful source of improving production than even improved seed, and in fact in Japanese Agriculture the two always go together to get the maximum benefit. Experience in Madras has always shown that this is the ideal thing to do. The comparative low price of foodgrains was however a great obstacle against cultivators taking up intensive manuring practices with the result that the best out of the improved varieties could not be realized. Things have however changed and people have become fertilizer-conscious, but unfortunately sufficient quantities of fertilizers are not available. The present position is not likely to improve in the very near future. Since the war, Japan is also suffering for want of sufficient quantities of fertilizers. The only course left open to us is to exploit other sources. Oilcakes, bone-meal, composts and green manuring can be thought of.

Of these, quantities available of the first are not unlimited and it would be more economical to use them in limited quantities in conjunction with the last two. In fact green manuring has proved the best and cheapest form of fertilizing rice crop everywhere, and there is no doubt that all our efforts at present should be concentrated on popularizing green manuring wherever it can be done. Applying small quantities of fertilizers along with composts or green manure should be the best form of manuring rice.

Although experimental data on manuring practices are not available in India on the scale existing in Japan, we have sufficient information to go on with for the next few years until more critical data as applicable to small individual areas could be obtained. It has to be remembered that the quantities of manurial ingredients, namely, nitrogen and phosphoric acid, applied in Japan are roughly three to four times those which we are recommending in India in the 'grow more food' campaign. Experimental evidence available does show that these quantities can be safely increased to twice or even three times the present level only in certain tracts of India. The use of night soil, both raw and composted, is very common in Japan whereas it is almost completely wasted in India.

Cultural Practices

While transplanting is the universal practice in Japan, in parts of India direct broadcasting still obtains even where facilities for transplanting do exist. How this can be changed needs immediate consideration. Transplanting will be the only way of keeping down weeds which are mainly responsible for lower yields in broadcast fields. Holdings in Japan being small as in India there are not any improved practices of preparing the land which obtain in Japan and which can be usefully copied here. Small improved tools are however used in Japan for threshing, shelling of grain, polishing, etc., and there appears to be definite scope for such improved implements in India too. In fact in Japan all the preparation of the land is done by hand and cattle are used only where the size of the holding is more than three acres. It has to be admitted that the small Indian rice farmer does not put in so much of hard labour in the field as his Japanese opposite does.

Extension Service

It is here we find the greatest difference between Japan and India. While we are not far behind Japan in the availability of technical information, it is in the application of such information in actual cultivation practice that India has to learn from Japan. The organization and the strength of personnel is very different in the two countries. That Japan has a technician for every two or three square miles is

something which India cannot hope for even after several years. Even in Indian Provinces where there is an agricultural demonstrator for each *taluka*, there is not much personal contact between him and the farmers. Things have become even worse in recent years as most of the demonstrators' time is taken up in the business aspects of selling seeds, manures, iron, etc.

References

1. Leonard, W. H. Rice as a Crop in Japan. *Jour. Amer. Soc. Agron.* 40 : 7 : 579-602, 1948.
2. Morinaga, T. Improvement in Rice Culture in Japan. (*Unpublished Note by the Director, Imperial Agricultural Experiment Station, Tokyo, Japan, made available to the senior author*).
3. Ramiah, K. Important Features of Rice Cultivation in Japan. (*Unpublished Note based on the discussions of the senior author with rice technicians present at the International Rice Commission of the FAO at Bangkok*).
4. Salmon, S. C. Crop Improvement in Japan. *Jour. Amer. Soc. Agron.* 40 : 11 : 1017-35, 1948.

IMPROVED STRAINS OF PADDY IN MYSORE

BY T. SRINIVASAMURTHY

Senior Asst. Botanist in charge of Paddy Work

MONSOON (KARTHIKE) SEASON

- S. 661 A selection from G.E.B. 24 of Coimbatore.
- (1) Planting Season July and August.
 - (2) Duration 130-50 days from planting.
 - (3) Average Yield per Acre 2,850 lb. of grain on Paddy Breeding Station, Nagenahally.
 - (4) Percentage of Rice to Paddy 52% by volume and 72% by weight.
 - (5) Paddy Straw colour.
 - (6) Rice Small fine grains, white.
 - (7) Diseases and Pests Low susceptibility to *Helmenthosporium* and *Piricularia*.
 - (8) Brief Description Tillers freely, non-lodging, erect and slightly spreading, yield of straw not as good as several local varieties like kaddy, etc. Has become popular as Coimbatore sanna. Suitable for cultivation under channels and major tanks. Being season-bound, earlier planting gives higher yield. Responds to good manuring.
- S. 699 A selection from Coimbatore sanna.
- (1) Planting Season July and August.
 - (2) Duration 130-35 days from planting.
 - (3) Average Yield per Acre 2,800 lb. of grain on Paddy Breeding Station, Nagenahally.
 - (4) Percentage of Rice to Paddy 51% by volume and 71% by weight.
 - (5) Paddy Straw colour.
 - (6) Rice White, fine, long and stout.
 - (7) Diseases and Pests Susceptible to *Helmenthosporium* and *Piricularia*.
 - (8) Brief Description Tillers freely, tendency to lodge in rich soils. Has become popular as Coimbatore kaddy. Suited for cultivation under channels and major tanks. Responds to good manuring.
- S. 139 A selection from Mysore kaddy.
- (1) Planting Season July and August.
 - (2) Duration 150-65 days from planting.
 - (3) Average Yield per Acre 2,800 lb. of grain on Paddy Breeding Station, Nagenahally.
 - (4) Percentage of Rice to Paddy 49% by volume and 68% by weight.

- | | |
|------------------------|---|
| (5) Paddy | Straw colour. |
| (6) Rice | Medium white. |
| (7) Diseases and Pests | Generally free from diseases. |
| (8) Brief Description | Medium tillerer, grows to a height of 5-6', yields good straw, tendency to lodge, tolerant to moderate alkalinity. Has become popular as farm kaddy. Long duration crop. Suited for cultivation under channels and major tanks. |
-
- | | |
|---------------------------------|--|
| S. 749 | A selection from Rathnachoodi. |
| (1) Planting Season | July and August. |
| (2) Duration | 150-60 days from planting. |
| (3) Average Yield per Acre | 3,300 lb. of grain on Paddy Breeding Station, Nagenahally. |
| (4) Percentage of Rice to Paddy | 52% by volume and 75% by weight. |
| (5) Paddy | Piebald brown in colour. |
| (6) Rice | Fine and dull white. Cooked rice slightly creamy in colour. |
| (7) Diseases and Pests | Comparatively resistant to <i>Piricularia</i> . |
| (8) Brief Description | Erect, non-lodging, non-shedding and free tillering with dark green leaves. Yield of straw good. Responds to good manuring. Has become popular as Rathnachoodi or Garudakembuthy. Suited for cultivation under channels and major tanks. Long duration crop. |
-
- | | |
|---------------------------------|---|
| S. 718 | A selection from Rathnachoodi. |
| (1) Planting Season | July and August. |
| (2) Duration | 140-50 days from planting. |
| (3) Average Yield per Acre | 3,600 lb. of grain on Paddy Breeding Station, Nagenahally. |
| (4) Percentage of Rice to Paddy | 52% by volume and 72% by weight. |
| (5) Paddy | Brown. |
| (6) Rice | Medium in size, dull white. |
| (7) Diseases and Pests | Fairly resistant to <i>Piricularia</i> , stray attack of <i>Ephelis</i> . |
| (8) Brief Description | Similar to S.749, slightly earlier. Responds to good manuring. Has become popular as <i>Neelam sanna</i> . Suited for cultivation under channels and major tanks. |
-
- | | |
|---------------------------------|--|
| S. 246 | A selection from Nagpur sanna or Muthina sanna. |
| (1) Planting Season | July and August. |
| (2) Duration | 120-35 days from planting. |
| (3) Average Yield per Acre | 2,400 lb. of grain on Paddy Breeding Station, Nagenahally. |
| (4) Percentage of Rice to Paddy | 46% by volume and 68% by weight. |
| (5) Paddy | Straw colour. |

- (6) Rice Very fine, slender, white, tendency to break in milling.
- (7) Diseases and Pests Stray attack on *Helmenthosporium* and *Ephelis* noticed.
- (8) Brief Description Medium tall, straw, thin and weak, tendency to lodge. Responds to good manuring.
Suited for cultivation as a table variety for channel areas and major tanks.

S. 624

- A selection from Maharajabhogam.
- (1) Planting Season July and August.
- (2) Duration 150-60 days from planting.
- (3) Average Yield per Acre 2,750 lb. of grain on Paddy Breeding Station, Nagenahally.
- (4) Percentage of Rice to Paddy 49% by volume and 68% by weight.
- (5) Paddy Straw colour.
- (6) Rice White and flinty.
- (7) Diseases and Pests Free from *Piricularia*, susceptible to *Helmenthosporium* and *Ephelis*.
- (8) Brief Description Erect and compact, poor tillerer, requires close planting, straw thick and non-lodging.
Suited for cultivation under channel areas and major tanks as a table variety.

S. 684

- A selection from Coimbatore sanna.
- (1) Planting Season July and August.
- (2) Duration 130-50 days from planting.
- (3) Average Yield per Acre 2,500 lb. of grain on Paddy Breeding Station, Nagenahally.
- (4) Percentage of Rice to Paddy 52% by volume and 75% by weight.
- (5) Paddy Straw colour.
- (6) Rice Fine white.
- (7) Diseases and Pests Slightly susceptible to *Helmenthosporium* and *Piricularia*.
- (8) Brief Description Medium tall, free tillerer, non-lodging. Has become popular as Coimbatore sanna.
Suitable for cultivation in channel areas and under major tanks. Rice slightly finer.

S. 199

- A selection from Alur sanna.
- (1) Planting Season July and August.
- (2) Duration 110-50 days from planting.
- (3) Average Yield per Acre 2,262 lb. of grain on Hebbal Farm.
- (4) Percentage of Rice to Paddy About 50% by volume and 69% by weight.
- (5) Paddy Straw colour. Tendency to awn.
- (6) Rice Long, medium, fine, white.
- (7) Diseases and Pests Found to be free from *Piricularia*. Stray infection of *Ephelis* noticed.

- (8) Brief Description Plants tall, moderately tillering, straw weak and lodges badly.
Suited to tank-fed areas and dry-sown for punaji cultivation.

H. 294

A selection from Doddabyra.

- (1) Planting Season July and August.
(2) Duration 110-50 days from planting.
(3) Average Yield per Acre 2,262 lb. of grain on Hebbal Farm.
(4) Percentage of Rice to Paddy About 50% by volume and 69% by weight.
(5) Paddy Dirty brown with deep furrows.
(6) Rice Coarse and red.
(7) Diseases and Pests Fairly resistant to *Piricularia*.
(8) Brief Description Medium tall, non-lodging.
Suited for punaji cultivation in Bangalore and Kolar Districts.

H. 320

A selection from Hunasehuvina batha.

- (1) Planting Season July and August.
(2) Duration 130-35 days from planting.
(3) Average Yield per Acre 3,022 lb. of grain on Hebbal Farm.
(4) Percentage of Rice to Paddy About 50% by volume and 69% by weight.
(5) Paddy Dirty brown with furrows.
(6) Rice Short and stout, white.
(7) Diseases and Pests Fairly tolerant to *Helmenthosporium* and *Piricularia*.
(8) Brief Description Plants tall, free tillerer, yields heavy straw, tendency to lodge.
Suited for punaji cultivation in Bangalore and Kolar Districts.

MALNAD VARIETIES

B. 194

A selection from Musalli.

- (1) Planting Season July. If sown, May-June.
(2) Duration 120-30 days from planting.
(3) Average Yield per Acre 3,000 lb. of grain on Bikli Farm.
(4) Percentage of Rice to Paddy 51% by volume and 69.5% by weight.
(5) Paddy Straw colour.
(6) Rice Medium coarse, white and semi-translucent.
(7) Diseases and Pests No disease has been observed so far.
(8) Brief Description Medium tall, good tillerer, strong straw, non-lodging. Generally sown dry before the commencement of monsoon and not ordinarily transplanted.
Suited for heavy rainfall areas of Chickmagalur and Hassan Districts.

- B. 16* A selection from Togarind.
- (1) Planting Season July, If sown, May-June.
 - (2) Duration 130 days from planting.
 - (3) Average Yield per Acre 2,350 lb. of paddy on Bikli Farm.
 - (4) Percentage of Rice to Paddy 52% by volume and 70% by weight.
 - (5) Paddy Mottled brown.
 - (6) Rice Coarse, white and semi-translucent.
 - (7) Diseases and Pests Very susceptible to "Leptispa beetle".
 - (8) Brief Description Medium tall, erect, non-lodging, good tiller, straw strong and pigmented. Suited to very heavy rainfall area of Shimoga District.
- B. 281* A selection from Bilikannuhegge.
- (1) Planting Season July. If sown, June.
 - (2) Duration 125-35 days from planting.
 - (3) Average Yield per Acre 3,580 lb. of paddy on Bikli Farm.
 - (4) Percentage of Rice to Paddy 50% by volume and 69% by weight.
 - (5) Paddy Straw colour.
 - (6) Rice Coarse, white and semi-transparent.
 - (7) Diseases and Pests No disease has been observed.
 - (8) Brief Description Tall, erect and free tillering and non-lodging, pigmented. Suitable for heavy rainfall areas and for transplantation.
- W. 3629* A selection from Walya.
- (1) Planting Season July-August. If sown, June.
 - (2) Duration 140-50 days from planting.
 - (3) Average Yield per Acre 2,440 lb. of paddy on Marthur Farm.
 - (4) Percentage of Rice to Paddy About 50% by volume and 69% by weight.
 - (5) Paddy Straw colour.
 - (6) Rice White, stout.
 - (7) Diseases and Pests No disease observed so far.
 - (8) Brief Description Medium tall, good straw, non-lodging. Suited for dry-sowing or transplanting in semi-mahad areas.
- H. O. 529* A selection from Honasu.
- (1) Planting Season July-August. If sown, June.
 - (2) Duration 140-50 days from planting.
 - (3) Average Yield per Acre 2,380 lb. of paddy on Marthur Farm.
 - (4) Percentage of Rice to Paddy 51% by volume and 70% by weight.
 - (5) Paddy Reddish brown.
 - (6) Rice Medium white.
 - (7) Diseases and Pests Diseases not noticed.

- (8) Brief Description Medium tall, good tillerer and non-lodging. Suited for dry-sowing or transplanting in semi-malnad areas.

B. 1399

A selection from Puttabatha.

- (1) Planting Season July.
 (2) Duration 120 days from planting.
 (3) Average Yield per Acre 3,000 lb. of paddy on Bikli Farm.
 (4) Percentage of Rice to Paddy 50% by volume and 67% by weight.
 (5) Paddy Tawney colour with deep furrows.
 (6) Rice Short, roundish and white.
 (7) Diseases and Pests Fairly free from diseases.
 (8) Brief Description Medium tall, good tillerer, strong straw, good yield of straw, semi-erect, non-lodging, pigmented.
 Suited for heavy rainfall areas.

B. 1370

A selection from Puttabatha. Similar to *B. 1399*. But rice is red and gives higher yield.

SUMMER (VAISAKE) SEASON STRAINS

S. 705

A selection from Yerradummavadlu or Bangarakaddi of Kolar.

- (1) Planting Season Can be grown in all seasons, particularly as summer crop—January-February.
 (2) Duration 90 days from planting.
 (3) Average Yield per Acre 2,600 lb. of paddy on Hebbal Farm.
 (4) Percentage of Rice to Paddy 52% by volume and 71% by weight.
 (5) Paddy Brown.
 (6) Rice Fine, dull white and flinty.
 (7) Diseases and Pests No diseases. Stray cases of *Ephelis* noted.
 (8) Brief Description Medium tall, generally non-lodging. Sparse tillerer, fairly drought-resistant and can be cultivated under intermittent irrigation and can either be sown or transplanted.
 Suitable for summer cultivation as an early crop or where double-cropping is taken.

S. 317

A selection from Halubbalu.

- (1) Planting Season Can be grown in all the seasons, particularly as summer crop—January-February.
 (2) Duration 105 days from planting.
 (3) Average Yield per Acre 2,350 lb. of paddy on Hebbal Farm.
 (4) Percentage of Rice to Paddy 52% by volume and 74% by weight.
 (5) Paddy Straw colour.
 (6) Rice Medium, dull white.

- (7) Diseases and Pests Susceptible to *Helminthosporium*.
 (8) Brief Description Medium tall, fair tillerer, non-lodging.
 Can also be planted during March-April
 and September-October.

- H. 497* A selection from Bangartheege.
 (1) Planting Season January-February as a summer crop. Can
 be cultivated in all the seasons.
 (2) Duration 105 days from planting.
 (3) Average Yield per Acre 3,100 lb. of paddy on Hebbal Farm.
 (4) Percentage of Rice to Paddy 48% by volume and 68% by weight.
 (5) Paddy Yellowish brown.
 (6) Rice Long, slender and white.
 (7) Diseases and Pests Fairly tolerant to *Piricularia*.
 (8) Brief Description Medium tall, tendency to lodge.
 Suited for cultivation, particularly for sum-
 mer season under tanks and for double
 crop areas.

Some Promising Strains under Trial

- S. 1092* A selection from the cross between Ban-
 garakaddi (S. 705) and Coimbatore sanna
 (S. 661).
 (1) Planting Season July-August.
 (2) Duration 140-50 days from planting.
 (3) Average Yield per Acre 2,810 lb. of paddy for the two years on
 Paddy Breeding Station, Nagenahally.
 (4) Percentage of Rice to Paddy 52% by volume and 74% by weight.
 (5) Paddy Reddish brown.
 (6) Rice Fine and white.
 (7) Diseases and Pests No diseases have been observed so far.
 (8) Brief Description Tall, free tillerer, non-lodging, yields good
 straw.
 Suited for trial for channel areas and major
 tanks.
- S. 1088* Another selection from the crops between
 Bangarakaddi (S. 705) and Coimbatore
 sanna (S. 661).
 (1) Planting Season July-August.
 (2) Duration 140-50 days from planting.
 (3) Average Yield per Acre }
 (4) Percentage of Rice to Paddy }
 (5) Paddy } Same as above, i.e., S.1092 paddy.
 (6) Rice }
 (7) Diseases and Pests }
 (8) Brief Description }

- S. 1073* A selection from cross between *S. 269* and *S. 661*.
- (1) Planting Season July-August.
 - (2) Duration 130-40 days from planting.
 - (3) Average Yield per Acre 2,740 lb. of paddy for 2 years on Nagena-hally Paddy Breeding Station.
 - (4) Percentage of Rice to Paddy 52% by volume and 74% by weight.
 - (5) Paddy Straw colour.
 - (6) Rice Fine and white.
 - (7) Diseases and Pests Diseases have not been noticed so far.
 - (8) Brief Description Tall, free tillerers, yields good straw. Suited for trial under tanks and channels as an early crop.
- S. 1079* Same as above, *i.e.*, *S. 1073* paddy.
- CH. 45* This is an introduction from China.
- (1) Planting Season Seems to do well for monsoon and summer season.
 - (2) Duration About 100-105 days from planting.
 - (3) Average Yield per Acre 1,850 lb. of paddy (summer crop) on Hebbal Farm.
 - (4) Percentage of Rice to Paddy
 - (5) Paddy Straw colour.
 - (6) Rice White.
 - (7) Diseases and Pests So far no diseases have been noticed.
 - (8) Brief Description Medium tall, non-lodging, good tillerer, fairly drought-resistant. Suited for trial where double cropping is taken.
- ANKLO 1-6* One of the introductions from Baroda.
- (1) Planting Season June-July.
 - (2) Duration 100-05 days from planting.
 - (3) Average Yield per Acre 800-1,200 lb. of grain per acre.
 - (4) Percentage of Rice to Paddy About 51% by volume and 70% by weight.
 - (5) Paddy Straw colour.
 - (6) Rice White and fine.
 - (7) Diseases and Pests No diseases have been observed so far.
 - (8) Brief Description Medium tall, good tillerer, non-lodging, fairly drought-resistant. Suited for trial for dry cultivation in low-lying fields and where there are facilities for one or two irrigations. Can also be tried for punaji cultivation.

SUBSIDIARY FOODS*

BY A. K. YEGNA NARAYAN AIYAR

(Formerly Director of Agriculture, Mysore)

THE acute shortage of food grains which this country has been experiencing for the last seven years and the remedial measures taken by the Government are extraordinary in many respects. India has had many famines in the past, some of them unsurpassed in their vastness and severity, but none has lasted so many years nor prevailed so universally through the length and breadth of the land. Moreover, the shortage continues in spite of the stupendous annual imports of all kinds of grains from every possible country in the world, and of the strenuous attempts at increasing home production. As regards remedial measures, while in the past, Government has tried to fight famines by the opening of famine camps and carrying relief only to the needy and the destitute, in the present case Government has taken upon itself the duty of feeding everyone, a truly superhuman task. This measure of giving each one his daily bread across a ration shop counter has landed Government in an impossible situation, the task being found more and more difficult on the one hand and the system itself once-initiated impossible to abandon without risk of serious consequences, on the other. The only way out of this baffling dilemma is increased production. The vast schemes of land reclamation and settlement, the numerous irrigation projects, the fertilizer factories and other schemes which are all under way are admirably well-conceived and have only to be speeded up. In regard to phosphatic fertilizers, however, I may point out that in view of the scarcity of sulphur and sulphuric acid the manufacture of superphosphate should no longer be attempted but that the isolation of elemental phosphorus and the manufacture of ammonium phosphate should be taken up instead.

The role of subsidiary foods in this gigantic set-up can but be small, but a knowledge of what they are and how they can be used will help the public to eke out their meagre ration, may relieve the pressure on the demand for cereals to some extent and may even stimulate research leading to a permanent increase in our food resources. At any rate, every little attempt helps in these difficult times and this will justify attention being bestowed on them.

What are these so-called subsidiary foods? They are, as the name implies, distinguished from the *staple* foods, and comprise those which can supplement or even partially substitute the staple foods. They are

* Reproduced from the book *Food and Population and Development of Food Industries in India*, published by Central Food Technological Research Institute, Mysore, by courtesy of the Director,

generally less difficult of cultivation and imply a somewhat unused abundance being consumed only to a smaller extent. Although it is chiefly as suppliers of starch, energy- or heat-producing components of foods and especially as a supplement to or substitute for rice that they have been familiarized, they may include complete foods as well and also those that make up deficiencies of particular components. I shall deal with all of them briefly.

Among such starch supplying subsidiary foods the most notable are the many edible roots or tubers, *i.e.*, the underground swollen stems and roots in which some plants store up starch. Examples are potatoes, sweet potatoes, tapioca and many others to which reference is made elsewhere in this paper.

The tapioca is by far the richest among them, with a starch content of about 38 per cent. Having been introduced over a century ago into Travancore by one of its far-seeing Maharajas, it is there that the crop is grown extensively at present. It is a 10-12 month crop, and yields abundantly, requiring a high rainfall or moderate irrigation. The roots contain a certain amount of the poison, prussic acid, and can be eaten only after being boiled. It can be eaten like a boiled vegetable, or dried and ground and made into a flour or meal. In either form it can very materially supplement rice. The flour however has industrial uses and as sizing material is in great demand in the textile mills (which are formidable competitors with it as a food). This is similar to using casein for plywood glue and for umbrella handles while the need for food is so great in the country. It is a question whether such use or misuse of food should not be forbidden.

The sweet potato comes next with a 31 per cent. starch content ; its use is safe and well known. It is a much satisfying food and is often the poor man's standby during famines. Its cultivation and use deserve to be increased.

The potato is really the king of tuber crops ; it gives a crop in 90 days, two crops can be grown in the year, with a third crop of short season *ragi* or maize in addition under intensive cultivation. Though grown only on the hills and plateaux, it can be grown on the plains also in the cold weather. Its starch content is about 25 per cent. but a single crop may yield up to five tons of the tuber.

The yams like the elephant yam, 'Surangadde' (*Amorphophallus conopsea*), and the colocasias, like *C. antiquorum* (Samegadde) are well-known edible roots which yield abundantly and are in general use.

The roots of the *Dioscoreas* attain remarkable sizes, of even 25 lb. and in one species, *viz.*, *D. alata* is said to have reached 85 lb. It may not be generally known that attempts were made some fifty years ago to popularize West Indian varieties in India by one Mr. Mitchell

in Calcutta. Though this has not caught on, many local varieties are already under cultivation and are common vegetables ; these are the species *alata*, *globosa*, *purpurea*, and *sativa*.

Coleus parviflorus yields an excellent tuber in abundance and deserves to be cultivated largely.

The fruit called *Singara nut* (*Trapa bispinosa*) is a great standby in Kashmir, Bengal and Bihar. It is an aquatic plant and many tanks and lakes can be used for growing it ; it does not therefore compete for land with other crops. In Kashmir it is reported to furnish food for five months in the year to 30,000 people and that one lake alone, the Wulur lake, yields 100,000 ass-loads of the nut per year. It is a six months' crop with a starch content of 25 per cent., and is eaten boiled, popped, or roasted and ground. It is eminently worthy of introduction in other parts of the country as well.

The arrow-root which grows both wild and in a cultivated state to some extent, both in the West coast and in the Orissa State, yields an excellent and well-known flour, estimated at about 13 per cent. on the weight of the fresh-roots, while the edible cannas more or less come in the same class.

The seed of the jack fruit comes in a separate class ; it is almost a by-product, but has nearly 40 per cent. starch. It can keep, and so can be had both in the jack season and out of it. It can be eaten toasted, boiled or made into flour.

The cooking plantains and desert plantains are other good sources of starchy (or sugar) foods, and are too well known to be described.

The papaya fruit holds great possibilities. It yields abundantly. The green fruit can be used as a vegetable while the ripe fruit is as satisfying as a meal. In one's and two's every household can grow it and make a substantial addition to its food supply.

The seeds of the Amaranthus paniculatus (Kannada—Rajakere or Horigire) afford a rich source of starch and are eaten fried or popped. One story goes that it was the means of saving many lives in one of the famines in Mysore. It grows wild and is also cultivated to a small extent, but deserves to be extended.

Buckwheat (which is not a cereal) is another crop worthy of larger cultivation. It is a ninety-day crop, can thrive on rough poor soils and at present has some vogue in Northern India. The flour is a highly esteemed food, considered more nourishing than many cereals, and may amount to half the weight of the seed. The seed has however to be broken and the seed-coat removed to get at the flour.

The next group comprises *the grains and pulses*, which can in one sense be called 'subsidiary' also, and constitute far and away the most important group. Where rice or ragi is the staple food, for

example, wheat and the other grains become subsidiary and *vice versa*. It is possible that a diet of more than one cereal is better than that confined to a single cereal, and these subsidiary foods may therefore be found to play a very important role. The pulses have the distinguishing merit of being proteid foods besides containing large quantities of starch, so that they furnish both the components. They may be available in plenty when rice may not be, and hence they may be used to make up the deficiency. The vogue of eating fried and salted pulses, including groundnuts, as a snack is to be welcomed. Groundnuts are indeed weight for weight about 50 per cent. more energy-supplying than rice.

All the foods listed so far can be prepared into a number of dishes and this opens out a wide field for the exercise of the culinary talent of our women-folk, some of whom are wizards in the art and can work wonders with them. I can personally testify to the excellence of many dishes prepared out of the so-called inferior grains like *ragi*, *bajra*, *jola*, etc. What is wanted is a big demonstration drive, in which all the hotels and restaurants should actively co-operate.

I must, however, deprecate the processing or camouflaging of the staple foods, into the so-called synthetic grains, patent foods, alimentary pastes and powders and so on. It will be easy enough to prepare balanced and fortified mixtures, of this kind, but in doing so the grains lose their identity and this will straightaway open the door to all kinds of adulteration in unscrupulous hands, besides withdrawing good and much sought-after food from the direct consumption market and processing them into forms of doubtful merit which will in any case need much popularization. It is a great safety that in our country rice and other grains are bought and sold as such and not as flour or bread.

A more fruitful field for research and a less objectionable one, if one may say so, will be in discovering new sources of food products. Many a vegetable product such as root, leaf, flower and fruit now available in abundance though rich in food, cannot be used as such on account of their association with unpalatable, or deleterious compounds, which if discovered and removed, will render the parent article fit for human consumption.

The so-called '*famine foods*' come under another class ; they are eaten only when sheer hunger drives people to do so. Many years ago a collection of fifty odd articles of this kind, was sent up for analysis, to the Mysore Department of Agriculture and some work was done on them, though it was not pursued—I append a list of these, together with their analysis ; I mention this only to show that research may be able to render many of them more suitable as food.

I now come to the next group, *viz.*, *animal food*. The most important among them is fish. With its enormous sea-board and fresh-water lakes and rivers, India's resources in fish are almost inexhaustible. The Royal Commission on Indian Agriculture stressed the importance of fish food in a country where rice is the staple food and strongly recommended its development. Fish is indeed the food which has helped Japan to maintain a dense population, on the minimum of rice land. Besides feeding her own population, Japan exports annually marine products including agar-agar to the value of 300,000,000 yen. In India little has been achieved, despite the great need and scope. A vast permanent source of food thus remains untapped.

The next is poultry, eggs and, I may add, pigs. These are means of converting the by-products and waste materials of the farm and the home into valuable human food, and deserve utilization to the full. War-time food production in Great Britain centred much round these products and the methods are worth copying. It is peculiar that in India agriculture is associated in the public mind with crop production alone, whereas, a farmer raises not only crops but produces milk, poultry and eggs, rears a few sheep, fattens a pig or two and, if conditions permit, goes out after game ; the products of the chase in India are by no means insignificant and deserve greater attention. To this long list, miscellaneous food products like dried yeast from molasses, mushrooms both wild and cultivated, sea-weeds and so on, may be added, all of which can be profitably developed.

We have practically unlimited resources in food, but they need developing ; and so far as these subsidiary foods are concerned, what is required is a good deal of propaganda on the part of the Government, a spirit of responsive co-operation on the part of the public as a line of immediate action and scientific research as a long range and continuous activity even after the present crisis is past.

APPENDIX

(Taken from the Eighth Annual Report of the Agricultural Chemist in Mysore for the year 1906-07)

TABLE I
LIST OF "FAMINE FOODS"

NO. 1	LOCAL NAME 2	ENGLISH NAME 3	BOTANICAL NAME 4	DISTRICT FROM WHICH SENT 5	REMARKS BY THE SENDER 6
134	Gutti gadde	..	..	Kolar	The tubers are boiled with <i>dhal</i> and eaten mixed with salt. Delicate persons are said to develop rheumatism if they eat this food
135	Bendli soppu	Bastard sandal	<i>Erythroxylon monogynum</i>	"	The leaves are dried and boiled in water with salt
136	Devadari or gyadari soppu	Commonly known as the beal tree	<i>Aegle marmelos</i>	"	The leaves are dried, ground, mixed with <i>ragi</i> flour and cooked
137	Nauare genasu	..	..	Mysore	Eaten fried or boiled, said to produce cough
138	Sal genasu	..	..	"	..
139	Karane genasu	..	..	"	..
140	Kall genasu	..	..	"	..
141	Akki genasu	..	..	"	..
142	Adavi genasu	Species of yams	<i>Dioscorea</i>	Bangalore	..
143	Nose gadde	..	..	Kolar	The tuber is ground, mixed with tamarind and made into cakes
144	Kathale gadde	Aloe roots	<i>Agave Americana</i>	"	The soft portion in cut into pieces, boiled with a paste of tamarind, dried in the sun and eaten
145	Eachal hannu	Date fruits	<i>Phoenix silvestris</i>	"	..
146	Bettada Eachal hannu	..	<i>Phoenix farinifera</i>	"	..
147	Jambu Neralay Kayi	..	<i>Eugenia jambuloma</i>	"	..
148	Kare soppu	..	var. <i>obtusifolia</i> <i>Canthium parviflorum</i>	"	..

149	Kesavina gadde	..	..	<i>Alacacia antiquorum</i>	Tumkur	..
150	Mara genasu	..	Tapioca	<i>Manihot utilisima</i>	"	Cooked and eaten; or dried, ground and mixed with ragi flour and boiled and eaten
151	Atti kayi	..	Country fig	<i>Ficus glomerata</i>	"	
152	Yele genasu	..	..	<i>Dioscorea species</i>	Mysore	..
153	Honagonne soppu	..	..	<i>Alternanthera sessilis</i>	Kolar	..
154	Vishnukranthi soppu	..	..	<i>Evolvulus alsinoides</i>	"	..
155	Hunise beelja	..	Tamarind seeds	<i>Tamarindus indica</i>	"	Seeds, fried, husks removed, the cotyledons broken into pieces, boiled and eaten
156	Thangadi huvu	..	..	<i>Cassia auriculata</i>	Tumkur	..
157	Kesavina dhanu	..	..	<i>Alacacia antiquorum</i>	"	..
158	Chandramallige gadde	..	..	<i>Mirabilis jalapa</i>	Hassan	..
159	Bidaru Kalalay	..	Bamboo shoots	<i>Bambusa aurundinacea</i>	"	..
160	Vondalaga soppu	..	..	<i>Hydrocotyle Asiatica</i>	"	..
161	Kondal genasu	..	..	..	"	..
162	Noren genasu	..	..	<i>Dioscorea aculeata</i>	"	Eaten boiled
163	Seebe gadde	..	..	..	"	..
164	Byle genasu	..	..	<i>Dioscorea species</i>	"	..
165	Bikki kayi	..	..	<i>Gardenia gummiifera</i>	"	..
166	Makali beru	..	..	..	"	..
167	Goni hannu	..	..	<i>Ficus mysorensis</i>	Kadur	..
168	Alada hannu	..	Banyan fruit	<i>Ficus bengalensis</i>	"	..
169	Ananas hannu	..	Pine apple	..	Hassan	..
170	Gudugudi fruits	..	..	<i>Scutia Indica</i>	"	..
171	Chelvi genasu	..	..	..	Mysore	..
172	Kavali genasu	..	..	..	"	Eaten raw
174	Noolina genasu	..	..	..	"	..
175	Goddirasani da gadde	..	..	..	"	..
176	Kannay soppu	..	..	<i>Commelina communis</i>	Shimoga	..
177	Marakesavina gadde	..	..	<i>Alocasia species</i>	Kolar	..
178	Kadu nugge soppu	..	..	..	Mysore	..
179	Kadu haruve soppu	..	..	<i>Embelia ribes</i>	"	..
180	Koneri gadde	..	..	..	"	..
185	Ale soppu	..	..	..	Hassan	..
186	Navale bhatta	..	..	..	Mysore	..

TABLE I (Continued)

NO.	LOCAL NAME	ENGLISH NAME	BOTANICAL NAME	DISTRICT FROM WHICH SENT	REMARKS BY THE SENDER
1	2	3	4	5	6
209	Hedige genasu	Species of yams	<i>Dioscorea</i>	Shimoga	..
210	Bagani pith	..	<i>Caryota urens</i>	"	..
211	Bella genasu	..	..	"	..
212	Kayi genasu	..	..	"	Boiled and eaten
215	Kumbha genasu	..	..	"	..
216	Anne soppu	..	..	Hassan	..
219	Mulla genasu	..	..	Mysore	Boiled and eaten with or without honey
222	Chesaka seeds	..	..	"	Fried, ground and made into gruel; said to produce colic
226	Poonidi soppu	..	..	Hassan	..
228	Bale dhantu	Plantain stem	..	"	..
230	Akki thowdu	Rice bran	..	"	..
233	Byaladakayi	Wood apple fruit	..	Mysore	..
235	Bale gadde	Plantain root	..	"	..
240	Challe hannu	..	..	"	..
243	Yeesha soppu	..	<i>Terminalia hellerica</i>	"	..
252	Tare kayi	..	<i>Randia dumetorum</i>	Kadur	The inner fleshy portion cut and boiled with condiments
253	Bangari kayi	..	..	"	..
254	Chagache sappu	..	<i>Cassia tora</i>	"	Eaten like rice
260	Bidar akki	Bamboo seeds or rice	<i>Bambusa arundinacea</i>	"	..
265	Myari bhatta	..	..	Shimoga	It is stated that ants store 3 to 4 seers of this under ground. People used to go in search of these ant holes to collect this grain. It is ground into flour, boiled and eaten
268	Kadu ragi*	..	..	Chitaldrug	* Eaten during the famine of 1876-77 in Jagalur Taluk
269	Kathale dhantu*	Aloe stem	<i>Agave Americana</i>	"	..
270	Eachal dhantu*	Soft stem of country date	..	"	..
271	Jali beeja	Babool seeds	<i>Acacia Arabica</i>	"	..

	Thavaray gadde Pillagala gadde	Lotus rhizome	<i>Nelumbium speciosum</i> <i>Typha angustifolia</i>	Tumkur Chitaldrug	..
273	Agase soppu	..	..	..	The roots eaten raw or boiled. The roots
318	Tupre hannu	..	..	..	of one plant said to afford food for 2
323	Navare hannu	..	..	..	persons. Used in famine of 1876-77
349	Amle genasu	..	..	..	..
367	Thangadi soppu	..	..	..	..
383	Seege soppu	..	..	..	..
385	Hunise soppu	..	..	..	..
386	Solle hannu	..	..	..	..
391	Nagare hannu	..	..	..	..
393	Kurdi hannu	..	..	..	..
422	Burdi hannu	..	..	..	..
423		..	..	..	..

TABLE II
COMPOSITION OF "FAMINE FOODS"

NO.	LOCAL NAME		MOISTURE	NITROGEN	PROTEIDS	FAT	CRUDE FIBRE	CARBOHY- DRATES	ASH INSOLUBLE IN WEAK ACIDS OR ALKALIS
			%	%	%	%	%	%	%
137	Navare Genasu	..	8.76	0.86	5.37	0.71	4.45	79.80	0.93
138	Sal ..	..	11.11	1.31	8.18	0.76	4.64	74.40	0.97
139	Karane ..	..	8.93	1.58	9.87	1.43	14.30	65.10	1.00
140	Kall ..	..	8.10	1.08	6.75	1.76	5.28	77.85	0.68
141	Akki ..	..	8.26	1.09	6.81	1.60	4.36	79.36	0.32
142	Adavi ..	..	8.96	1.17	7.31	1.76	3.48	78.80	0.46
143	Nose Gadde	..	10.28	1.79	11.18	1.12	2.62	74.22	0.56
144	Kathale Gadde	..	7.96	0.67	4.18	0.45	3.01	84.30	0.06
146	Bettada Echal Hannu (wild date)		9.24	0.63	3.93	0.75	10.29	74.77	0.90
148	Kare soppu	..	6.77	2.27	14.18	3.14	15.14	59.53	..
149	Kesavina Gadde	..	6.16	0.91	5.68	0.92	9.99	77.23	..
150	Maragenasu (Tapioca)		3.14	0.60	3.75	1.91	7.05	83.23	..
151	Attikayi	..	10.85	1.21	7.56	4.10	15.45	61.66	0.36
152	Yele Genasu	..	6.64	1.48	9.25	2.03	14.81	65.66	1.98
153	Honagonne soppu	..	6.10	3.07	19.18	1.72	15.63	53.47	..
159	Bidaru kalalay	..	10.02	4.23	26.43	1.48	12.77	49.32	..
162	Noren Genasu	..	5.70	0.80	5.00	1.90	10.57	74.19	2.60
164	Byle Genasu	..	9.89	0.72	4.50	2.06	10.67	69.73	3.10
169	Pine apple fruits	..	9.72	1.08	6.75	0.34	8.58	74.26	0.20
170	Gudugudi fruits	..	8.54	0.51	3.18	0.54	8.61	78.41	0.60
171	Chelvi Genasu	..	5.69	1.65	10.31	0.64	9.91	71.87	1.50

TABLE III

"FAMINE FOODS" (*partially analysed*)

NO.	LOCAL NAME		NITROGEN
			%
134	Gutti Gadde	..	2.86
135	Bendle soppu	..	1.95
136	Devadari soppu	..	1.83
147	Jambu-Neraley-Kayi	..	0.82
154	Vishnukranthi soppu	..	2.22
155	Hunise Beeja	..	2.34
156	Thangadi huvu	..	1.47
157	Kesavina dhantu	..	1.05
158	Chandramallige Gadde	..	1.03
160	Vondalaga soppu	..	1.53
161	Kondal Genasu	..	0.82
163	Seebe Gadde	..	1.12
165	Bikki kayi	..	0.68
166	Makali beru	..	0.40
167	Goni hannu	..	1.16
168	Alada hannu	..	0.92
172	Kavali Genasu	..	1.37
173	Noori Genasu	..	1.63
174	Noolina Genasu	..	1.61
175	Goddirasanida Gadde Hittu	..	0.05
176	Kannay soppu	..	2.70
177	Marakeshavina Gadde	..	1.34
178	Kadunugge soppu	..	2.18
179	Kadu Harive soppu	..	1.51
186	Navale bhatta	..	1.64
209	Hedige Genasu	..	2.11
210	Bagani pith	..	0.06
216	Anne Soppu	..	2.44
224	Bidaru akki	..	1.80
226	Poondi soppu	..	3.33
230	Akki thowdu	..	1.57
253	Bongari kayi	..	0.69
254	Chagachi soppu	..	2.32
259	Kyyi Genasu	..	1.27
268	Kadu Ragi	..	2.65
270	Soft stem of country date	..	0.84
271	Babul seeds	..	6.06
273	Lotus roots	..	1.77
277	Deva Genasu	..	1.18
323	Agase soppu	..	4.67
375	Navare hannu	..	2.00
349	Tupre hannu	..	0.26
385	Seege soppu	..	4.97
386	Hunise soppu	..	1.83

TABLE II

ANALYSIS OF THE SOILS OF THE MYSORE DISTRICT

No. of samples		Name of the place		Date of analysis	
1		2		3	
4		5		6	
7		8		9	
10		11		12	
13		14		15	
16		17		18	
19		20		21	
22		23		24	
25		26		27	
28		29		30	
31		32		33	
34		35		36	
37		38		39	
40		41		42	
43		44		45	
46		47		48	
49		50		51	
52		53		54	
55		56		57	
58		59		60	
61		62		63	
64		65		66	
67		68		69	
70		71		72	
73		74		75	
76		77		78	
79		80		81	
82		83		84	
85		86		87	
88		89		90	
91		92		93	
94		95		96	
97		98		99	
100		101		102	
103		104		105	
106		107		108	
109		110		111	
112		113		114	
115		116		117	
118		119		120	
121		122		123	
124		125		126	
127		128		129	
130		131		132	
133		134		135	
136		137		138	
139		140		141	
142		143		144	
145		146		147	
148		149		150	
151		152		153	
154		155		156	
157		158		159	
160		161		162	
163		164		165	
166		167		168	
169		168		169	
170		170		170	
171		171		171	
172		172		172	
173		173		173	
174		174		174	
175		175		175	
176		176		176	
177		177		177	
178		178		178	
179		179		179	
180		180		180	
181		181		181	
182		182		182	
183		183		183	
184		184		184	
185		185		185	
186		186		186	
187		187		187	
188		188		188	
189		189		189	
190		190		190	
191		191		191	
192		192		192	
193		193		193	
194		194		194	
195		195		195	
196		196		196	
197		197		197	
198		198		198	
199		199		199	
200		200		200	
201		201		201	
202		202		202	
203		203		203	
204		204		204	
205		205		205	
206		206		206	
207		207		207	
208		208		208	
209		209		209	
210		210		210	
211		211		211	
212		212		212	
213		213		213	
214		214		214	
215		215		215	
216		216		216	
217		217		217	
218		218		218	
219		219		219	
220		220		220	
221		221		221	
222		222		222	
223		223		223	
224		224		224	
225		225		225	
226		226		226	
227		227		227	
228		228		228	
229		229		229	
230		230		230	
231		231		231	
232		232		232	
233		233		233	
234		234		234	
235		235		235	
236		236		236	
237		237		237	
238		238		238	
239		239		239	
240		240		240	
241		241		241	
242		242		242	
243		243		243	
244		244		244	
245		245		245	
246		246		246	
247		247		247	
248		248		248	
249		249		249	
250		250		250	
251		251		251	
252		252		252	
253		253		253	
254		254		254	
255		255		255	
256		256		256	
257		257		257	
258		258		258	
259		259		259	
260		260		260	
261		261		261	
262		262		262	
263		263		263	
264		264		264	
265		265		265	
266		266		266	
267		267		267	
268		268		268	
269		269		269	
270		270		270	
271		271		271	
272		272		272	
273		273		273	
274		274		274	
275		275		275	
276		276		276	
277		277		277	
278		278		278	
279		279		279	
280		280		280	
281		281		281	
282		282		282	
283		283		283	
284		284		284	
285		285		285	
286		286		286	
287		287		287	
288		288		288	
289		289		289	
290		290		290	
291		291		291	
292		292		292	
293		293		293	
294		294		294	
295		295		295	
296		296		296	
297		297		297	
298		298		298	
299		299		299	
300		300		300	
301		301		301	
302		302		302	
303		303		303	
304		304		304	
305		305		305	
306		306		306	
307		307		307	
308		308		308	
309		309		309	
310		310		310	
311		311		311	
312		312		312	
313		313		313	
314		314		314	
315		315		315	
316		316		316	
317		317		317	
318		318		318	
319		319		319	
320		320		320	
321		321		321	
322		322		322	
323		323		323	
324		324		324	
325		325		325	
326		326		326	
327		327		327	
328		328		328	
329		329		329	
330		330		330	
331		331		331	
332		332		332	
333		333		333	
334		334		334	
335		335		335	
336		336		336	
337		337		337	
338		338		338	
339		339		339	
340		340		340	
341		341		341	
342		342		342	
343		343		343	
344		344		344	
345		345		345	
346		346		346	
347		347		347	
348		348		348	
349		349		349	
350		350		350	
351		351		351	
352		352		352	
353		353		353	
354		354		354	
355		355		355	
356		356		356	
357		357		357	
358		358		358	
359		359		359	
360		360		360	
361		361		361	
362		362		362	
363		363		363	
364		364		364	
365		365		365	
366		366		366	
367		367		367	
368		368		368	
369		369		369	
370		370		370	
371		371		371	
372		372		372	
373		373		373	
374		374		374	
375		375		375	
376		376		376	
377		377		377	
378		378		378	
379		379		379	
380		380		380	
381		381		381	
382		382		382	
383		383		383	
384		384		384	
385		385		385	
386		386		386	
387		387		387	
388		388		388	
389		389		389	
390		390		390	
391		391		391	
392		392		392	
393		393		393	
394		394		394	
395		395		395	
396		396		396	
397		397		397	
398		398		398	
399		399		399	
400		400		400	
401		401		401	
402		402		402	
403		403		403	
404		404		404	
405		405		405	
406		406		406	
407		407		407	
408		408		408	
409		409		409	
410		410		410	
411		411		411	
412		412		412	
413		413		413	
414		414		414	
415		415		415	
416		416		416	
417		417		417	
418		418		418	
419		419		419	
420		420		420	
421		421		421	
422		422		422	
423		423		423	
424		424		424	
425		425		425	
426		426		426	
427		427		427	
428		428		428	
429		429		429	
430		430		430	
431		431		431	
432		432		432	
433		433		433	
434		434		434	
435		435		435	
436		436		436	
437		437		437	
438		438		438	
439		439		439	
440		440		440	
441		441		441	
442		442		442	
443		443		443	
444		444		444	
445		445		445	
446		446		446	
447		447		447	
448		448		448	
449		4			